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SOME NEGLECTED PARADOXES OF VISUAL SPACE. I

SEVERAL years ago I was led to ask myself certain questions about the blind spot and the periphery of the visual field. Observations giving at first a most oracular answer, I thumbed psychological literature for more light, but there even less was shining. Some of the questions nobody seems to have faced, while others had been disposed of in a manner indicative of haste, prepossessions, or lack of interest. That these attitudes were unwarranted, a study of the blind spot and peripheral phenomena quickly convinced me. Indeed, unless my observations and those of several persons who have kindly helped me are at fault, they have important bearings upon the theory of continuums and upon one's conception of consciousness. These bearings will be considered in later articles. At present, besides stating the facts about visual space at the blind spot and periphery, I shall try to show but one thing: namely, that the paradoxes here given perceptually are just what one must expect to flow logically from the hypothesis that the space we see is real space itself. If the reader can discern, in his own visual field, the puzzles I am about to recount, he will probably agree that the smoothness with which they fit into a natural-realistic theory of perception is presumptive evidence in favor of the latter.

The campimeter invoked the first question. With this instrument, we were told, the exact shape and size of the visual field (monocular, of course) could be charted. By the usual familiar method I secured a piece of paper with an irregular circle-like line, which was the ungainly contour of the territory my right eye saw. Being sceptically disposed, I tried to see whether the laboratory artist had drawn true to life; but I tried *by looking at the visual field itself.* In all innocence, I reasoned that, as everything I see has some shape and size, and as the visual field is, by definition, the totality of things seen (with one eye) at a given moment, therefore this totality must have a perceptible shape and size, however vague and wavering. This certainly rings true to orthodox logic; so it seemed but a matter of a few weeks' practise before the campimetric shape would, so to speak, become visible to the naked eye. This natural hope was blasted, though, and in its blasting there were laid bare some paradoxes which, for aught I know, have generally escaped notice.

It will not do first to seek the shape of the field by gazing with one eye at a sheet. Even skilled observers who do this often report the field to be visibly circular. Some say they see the curving rim somewhat blacker than the field just within it, while others declare the rim is not black but exists as a mere stopping-place, a sort of geometrical line, of no breadth, but yet somehow perceptible. The former were easily disposed of. Their black rim proved, by charting, to be the contour of nose and eyebrow seen well within the absolute periphery. When his eye was held in the normal line of vision, such an observer usually confessed that the rim was very hard to see in the temporal arc, where, as it happens, no part of his own face intrudes. The second type of observer proved more difficult; but, as eye movements were generally detected during fixation, the conjecture lay near at hand that the rim "of no visual breadth" meant only the kinesthetic quality of a faint outward circular sweep made in the paradoxical hope of seeing the margin by moving it in a little toward the center of clear vision. A second series of tests showed the truth of this guess. Observers were put in a dark room and spared the difficulty of fixation as well as the confusion of judgment due to the difference in color and sharpness of contour between central and peripheral objects. With the entire field an even black, every verdict agreed that there was no assignable shape, either symmetrical or irregular, clear-cut or hazy. It was not as if the margin were seen through a fog or were itself nebulous. There was no line or band of any sort, no limit at which anybody could say: "Thus far and no farther." I have made the observation hundreds of times and should now word it thus: for me, there is no more *spatial form* here than in a musical chord or a complex odor, but, just as in the chord there is some character which I should naturally call *spatiality*.

Once familiar with this experiment, one may safely resume tests with open eye and investigate my second question, viz., that about the limit of vision at some single point, which is naturally much more easily attended to than the whole fringe. Now let the observer face a white sheet of even illumination and, fixating in the normal line of vision, attend to the outer edge of, say, a black penholder whose tip has been thrust just over into the visual field. I know of no more difficult trick with any sense organ, nor of any which, when once mastered, yields such a peculiar, almost incommunicable, result. There is absolutely no analogy between the disappearance of the penholder and, say, that of a mountain peak into the clouds. However absurd the words sound to the logical ear, it is strictly correct to say that the penholder has absolutely no outer edge, no point which can be seen as the last, none whose next remove is visual nothingness. I am not simply uncertain where the penholder disappears, I am very sure that it is actually "boundless," as genuine and flawless a specimen of τὸ ἄπειρον in real life as Anaximander himself could wish for. Not that I perceive the penholder to go on and on forever; but in another sense, which one must find in his own perceptions in order to understand, and which we shall later investigate, it is extensively indeterminate in a unique manner. What this means, our third problem, the blind spot, will make clearer.

Nobody has made capital of the rather obvious fact that the blind spot is physiologically related to the visual field as the environs of the retina are. Both are insensitive regions organically adjacent to sensitive. The presumption is, then, that one's perception of the limit of vision is essentially the same at the blind spot and at the periphery. So it is, too. Not only do I find the ἄπειρον around the blind spot but, because the retina surrounds the latter, the ἄπειρον here shows more vivid detail than at the periphery. In spite of this, however, psychologists are at odds over the simplest description of the facts and still more fiercely over the interpretation. One group sees the blind spot as a "sehr verwaschener grauer Fleck" in the visual field; another declares it is not an element in the field at all, its region being filled in, as Wundt puts it, through reproduced sensations; and a third, very cautious, agrees with Ebbinghaus that nothing can be said about it, the case being analogous to the instant when we awake from dreamless sleep having no memories with which to fill in the interval and yet being aware that time has passed since we fell asleep. All three opinions state facts, but inexactly. True, if we look at a white field, we may note a diffuse, uncertain effect, which we may tentatively call gray, in the region of the blind spot; but by holding a black thread across the field so as to cut across the blind spot, we find that the gray, so far as it is distinguishable as gray, really fringes the spot itself. Careful attention to it along the path of the guiding thread shows unmistakably that the color is, on the side of the entering optic nerve, absolutely boundless. These words, I know, are absurdly coupled; what is on the side of anything *must*, by the very nature of this lateral relation, have a boundary, protests the logician. But, heedless of this, the paradox adds to its shrieking company a madder one, as soon as we describe the transit of the black thread across the blind spot. The thread disappears on one side of the spot and reappears on the other, *but without a break.* Most emphatically, it is not filled in by Wundt's reproduced sensations; I do not perceive it at all across the blind spot, but am clearly aware that it is invisible there. And yet where it becomes invisible, there is no last visible element.

Ebbinghaus is on the trail of this paradox, but does not quite catch it. His comparison of the blind spot with the "time-blindness" of dreamless sleep certainly suggests but does not precisely depict the situation. In dreamless sleep many organic sensations, too faint or too disorganized to be recalled discretely, doubtless occur, giving us a vague consciousness of lapsed time and so preventing our waking state from joining directly on to the last previous wakeful state, as it does in the case of absolute unconsciousness. The analogue—and Ebbinghaus regards it as nothing better—is unfortunate.

Strictly construed, it would mean either that the visual space elements adjacent to the absolute blind spot sense, in some mysterious way, the presence of an extension which is not itself sensitive; or else that there is in the visual field a genuine hole which vision itself can not fill in but which other varieties of space perception somehow manage to. In the final analysis, this second reading of the analogue simply defers the whole problem, which is that of describing what we actually see; to invoke "reproduced sensations" or auxiliary space-sensing organs is no more helpful here than to appeal to heredity or "local signs" or preestablished harmony. Be the *means* or *causes* of our seeing the visual field as we do what they may, we must still describe the field as it is, would we understand visual space as it is. Only the first sense of the analogue, therefore, claims our attention; but it does not square with facts. No extension is sensed across the blind spot. Near it, I sense extension but no color; and by "no color" I mean "no color," not a phantom gray or any other hazy, will-o'-the-wisp tint, but absolutely no more color or suggestion of color than I sense in a pin prick or a rose's odor. We have provisionally called the effect gray, in deference to custom, but we must now forbid the adjective. It is with respect to color as with peripheral form-perception, whereof Ebbinghaus correctly says, we do not perceive shapes simply in distortion or as through a fog or yet as with inaccurate accommodation, but rather are unable to establish *any* spatial order or even a respectable chaos. And as with color, so finally with extension itself. It does not change its nature near the blind spot or across it; it simply eludes us, as if space itself were slipping from our grasp into some foreign dimension whither no man pursueth.[1]

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[1] The paradox of colorless extension is given still more convincingly in the periphery, where, again, the effect is called gray simply because observers assume that, of course, everything one sees *must* have some color. This is not one of the differentiated colors, hence it must be gray—so runs the unconscious logic. The recent studies of peripheral after-images, such as Miss Grace Fernald's (*Psychological Review*, Vol. XV., p. 25), do not conflict with the above observations. They show that after-images appear at the periphery even when the tone of the color stimulus is not seen. By periphery, though, is meant the whole region beyond the paracentral. Thus, if I read the records correctly, an after-image from a red light striking the retina beyond the campimetric red-green zone is considered peripheral; so, too, an after-image from a blue light beyond the blue-yellow zone. I find, however, that the periphery, so defined, has several zones, three of which, in my own case, are easily and always demarcated. At the very rim, color and form are absolutely non-existent, directly or in after-images. In a zone just within this, there is a fluctuation between pure extension and some very uncertain color-form complex. For blue-yellow stimuli, this effect in my own case reaches out very far. The third zone, next to the campimetric blue-yellow field, gives a rather swift fluctuation between fairly clear and vague color-form vision. The paradoxes we are considering

Not long ago, such mysteries would have been dismissed as merely so much more evidence that mental life is neither a piece nor a picture of the physical world order, but an ideal island whence the marooned ego can not even signal to the mainland of reality. Today the wish is abroad to explain their like in a thoroughly realistic way, not to substitute one big obscurity for a dozen little ones. The attempt has not yet been made, I believe; all psychology, even the most materialistic, still speaks the language of idealism, or at least a dialect of it. But a beginning must be made, if psychology is to take its proper rank as a natural science. Now, it is not enough to borrow the methods of realistic research, the subject-matter itself must be realistically interpreted; and not for the sake of proving some realists's philosophy, but in the hope that, from the new point of view, some of the old spectres of psychology will be seen to be but mist.

Suppose we begin by accepting, as a working hypothesis, the natural belief that what is made immediately present to us through the assistance of the retina is real space, not a mere "sign" or "ideal correspondent" of a hypothetical outside space. It would at once follow that the elements of the visual field are not *in* space, for the excellent reason that they *are* space. Obviously, there is no possible sense in saying that a real space is itself in a realler one; one might as well say that a real blue is in a more general blue. Such perversions of the preposition "in" shoot through all philosophical literature, and a generation schooled in them will naturally cry heresy at the above inference. Could there be a more monstrous paradoxical insult to common sense than this allegation that a part of space is not contained in its whole? This misses the point, though. We wish to know just what we mean by "part" and "whole" and "containing," when speaking about extensions. For instance, have we to do here with a receptacle and its contents, or with a cake and a crumb of it, or with a thing and one of its qualities, or with a class and its members (a concept and its individual, differentiated cases)? Certainly, the natural realistic view is not that a real extension is, *as extension*, somehow tucked away in a bigger extension, as a barrel might be in a ship's hold. Mr. Bertrand Russell's distinction between "externality" and "spatial order" is one the ordinary man would insist upon, were he criticized for speaking of things as being "in" space. He means that the things themselves are qualified extensions and that, as extensions, they are related to one another in

have to do with the Ultima Thule of the periphery. To admit their existence here is, by the way, not equivalent to denying that under certain unusual conditions even the ultra-peripheral zone may sense color, at least in after-images. No less than logic, the astonishing adaptive powers of the retina warn us against such an inference.

a manner he describes as position or order. Extension, then, is a quality of some things—most conspicuously of visible things. I know this naïve description will provoke many a learned smile on lips ready to prove space an *a priori* form or a continuum of some mathematical-geometrical sort. But suppose we run, in a spirit of adventure if with no better grace, to the last implications of the innocently radical view. We find them straightening out all our paradoxes and thereby furnishing some little empirical evidence in favor of the realism on which the opinion is founded.

Those who consider visual areas as "in" or "projected into" an external physical area will pronounce our boundless and formless field as an illusion due to inaccurate language, feeble attention, or defective indirect vision. Those who treat each sensed extension as a real cosmic quality, rather than a "sign" or "mental state," must follow us to the point of saying that, even with a divinely perfect organ of vision and imperturable attention, every visual field must be visually boundless and formless because boundaries and forms, to be seen, must be "lines" of difference between seen things. For vision, there can never be anything outside the visual field, inasmuch as the latter is, *by definition,* the totality of characters seen at a given moment. This means that *visually* there is no outside to a visual field, hence no possibility of visual bounds to the latter. A visible boundary between the visible and the invisible is even more absurd than, say, an audible boundary (*i. e.*, an audible difference) between colors and sounds, or, better yet, a felt boundary between feeling and anesthesia. What, then, is the nature of the outermost visual elements? *They must be, in logic, pure extension without spatial order. And this we find them to be in reality.* "Something stretches out" at the periphery, but it is utterly amorphous; so, too, around the blind spot where not even the more highly developed color sensitivity and form-synthesis of adjacent retinal elements can give hue or shape to the "jumping-off place."[2] The extreme homogeneity of these regions is their one striking, baffling character; our inability to "say anything about them," of which Ebbinghaus complains, is the inevitable result of this, for *here we have to do with a single quality, namely extension, attached to no other, inhering in no object,* hence removed from the ordinary judgment which demands a subject and a predicate (a complex and an inhering or otherwise attached character). Strictly, we can not even say "something stretches out," but only "there is a stretching out."

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[2] Here, to be sure, the zone of pure extension is very much narrower than at the periphery because the retina has developed from its center outward, and also, it may be, because the rods and cones are distributed with a convex front around the blind spot but concavely at the periphery. This second point owes what plausibility it may enjoy to the hypothesis that spatial order depends, in some measure, upon the number of lines that are determined by two rods or cones on opposite sides of the rod or cone whose visual space-order is being measured. The geometry of this assumption, as well as its factual warrant, can not be sketched here. As for the first point, can histology and experimental psychology, between themselves, show any genetic correlation between perceptions of extension, form, and color, and the development of the three major strata of the retina? If so, some radical amendments to current theory would follow.

Suppose, now, we ask our naturally minded friends whether extension and quantity are identical. The answer, I think, will be pretty uniformly negative. Knowing nothing about the interminable wars of geometers and logicians over the preciser definition of these two concepts, an acute but unphilosophical person is disposed to say that, whatever each may be, one is not the other, inasmuch as we can inquire into the quantity of unextended things, such as geometrical points, pure number, complexity, time, happiness, etc. However intimately, therefore, extension and quantity are related, they are distinct and neither is reducible to the other. As a strong band of authorities is ready to defend this natural opinion, we need not be ashamed to follow it in its superficially bewildering implications, the first of which is that, if we can perceive pure extension, divorced from every other character, we shall perceive it as quantitatively indeterminate. And this means neither of uncertain quantity nor of zero quantity (*i. e.*, a visual point), but completely unamenable to the very category of quantity. With one slight qualification, this describes what I find at the blind spot and the periphery. Here is just such a genuine ἄπειρον in its pure state save for a certain positional value which it has; I see it to the right or to the left of objects in the clear field. But we know, by observation and by reasoning, that mere position does not bring our ἄπειρον under the category of quantity. It is well known that movements can be sensed in the periphery where shapes can not.[3] Far from being the paradox some psychologists would make it, though, it only confirms what everybody believes at first thought, namely, that position is not a "dependent phase" of extension or of quantity in the real world and hence need not be in the mental. Pure points have position;

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[3] Note that this is not Exner's statement, which Professor Stratton has brought under suspicion (cf. his "Visible Motion and the Space Threshold," *Psychological Review*, Vol. IX., pp. 433 f.). That statement is that motion may be perceived independently of all discrimination of positions. Neither the truth nor falsity of this affects in the least my observation that two extensions, each a boundless and formless character, can be distinguished as to position without their developing thereby any perceptible boundary between them. The paradox of motion in no (assignable) direction (first noticed in tactual space, I believe, by Hall and Donaldson) is so easily fitted into our naturalistic scheme, that we shall not consider it.

indeed, some geometers define them as being nothing save position, hence as constituting a relational order intimately connected with extension and quantity, but wholly distinct from these. Ere this, somebody has been itching to ask: "What of the continuity of visual space, and generally of real space, if all this is true?" The answer is our next duty.

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REVIEWS AND ABSTRACTS OF LITERATURE

The Moral Economy. RALPH BARTON PERRY. New York: Charles Scribner's Sons. 1909. Pp. xvi + 267. $1.25.

Professor Perry's little book is notable out of proportion to its size and pretensions. It is the most recent expression of the new spirit in ethics, which aims to get away from historic concepts and controversies back to the facts themselves of the moral life. Bishop Butler's saying is aptly taken as the motto of the book: "Things and actions are what they are, and the consequences of them will be what they will be; why then should we desire to be deceived?" The author's aim throughout is to exhibit morality as neither "a mystery nor a convention, but simply an observance of the laws of provident living," a rational meeting of the facts of life. For him, as for Socrates and the Greeks, moral conduct is enlightened conduct, the good man is the wise man. It is this naturalness and sanity of morality which he is concerned to emphasize in contrast to the Nietzschean view of it as artificial and restrictive, and this purpose he carries out with a singular simplicity and clearness of style and with a wealth of literary allusion which makes the book remarkable as an attractive and persuasive treatment of ethics. Although the work is called in some advertisements of it a text-book, the classification is hardly fitting, lacking as it does all the necessary machinery of paragraphing and bibliography: it is rather "a preliminary sketch of a system of ethics" adapted to all whom recent literature or social change has interested in the problem of rational living.

The topics discussed are essentially those of the usual text-book, though disguised under terms appropriate to the style of treatment: "Morality as the Organization of Life," "The Logic of the Moral Appeal," "The Order of Virtue," "The Moral Test of Progress," "Moral Criticism of Fine Art," "The Moral Justification of Religion." The author's standpoint might, perhaps, be characterized as that of naturalistic idealism or Græco-scientific idealism, combining as it does the Greek conception of morality as the natural flower of human life with the modern evolutionary account of its origin and process. Starting with the conception of the unit of life as the simple interest, or self-maintaining process, the condition for the moral life is found in the multiplication of interests which makes necessary their organization or economy. Goodness is relative to interest and consists in the satisfaction of the process or in the means